

## R E M A R K S

The above identified Office Action has been reviewed, the references carefully considered, and the Examiner's comments carefully weighed. In this regard, it is contended that by the present Remarks, all bases of rejection set forth in the Office Action have been traversed and overcome. Accordingly, reconsideration and withdrawal of the rejection is respectfully requested.

Applicants courteously wish to mention that a set of claims is not being provided herewith, as none of the claims are herein subject to an amendment.

### Rejection under 35 U.S.C. 103

#### Grounds for Rejection:

According to the Office Action, Claims 1-4 are rejected as being unpatentable over Liu et al in view of Zhu et al. In this regard, the Examiner indicates that Liu et al disclose all the claimed subject matter except as to the size of the piston. The Examiner then indicates that a large diameter piston is already known as taught by Zhu et al. The Examiner then concludes it would be obvious for an artisan of ordinary skill to combine these teachings so as to arrive at Applicants' claimed invention.

Further according to the Office Action, Claims 5-10 are rejected as being unpatentable over Liu et al in view of Zhu et al, and further in view of Paro. In this regard, the Examiner indicates that the addition of a polish ring to a slot in a cylinder for the reconstructed piston discussed above would be within the ken of an artisan of ordinary skill in view of the teachings

of Paro.

Finally according to the Office Action, Claims 11-12 are rejected as being unpatentable over Paro. In this regard, the Examiner indicates that Paro teaches all the claimed subject matter with the exception of the polish ring being integrally formed with the cylinder liner. The Examiner then concludes that an artisan of ordinary skill could arrive at Applicants' claimed invention because of art recognition as further evidenced by Applicants' claiming of alternative structures.

Applicants' Response:

In view of the present amendment, Applicants respectfully traverse each of the aforesaid grounds for rejection under 35 U.S.C. 103, for the reasons set forth in detail below.

MPEP Section 706 sets forth the test to be used when evaluating references under 35 U.S.C. 103. This test is that enunciated by the Supreme Court in Graham v. John Deere, 148 U.S.P.Q. 459, 466 (1966), where the Court held:

"Under section 103, the scope and content of the prior art is to be determined; the differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved; against this background, obviousness of subject matter is determined."

Applicants respectfully submit that Applicants' invention is not obvious over the above cited references when evaluated under the Graham test.

Discussion of the References at Issue:

Liu et al disclose a diesel engine piston having a crown bowl, wherein the crown bowl has a sidewall. The sidewall is provided with an acute re-entrant angle. Liu et al is silent as to the diameter of the piston crown.

Zhu et al disclose a diesel engine piston having a crown bowl, wherein the crown bowl has a sidewall. The sidewall is provided with an obtuse re-entrant angle. Zhu et al teach that an obtuse re-entrant angle sidewall is applicable to large diameter pistons, as for example 250 mm.

Paro discloses a diesel engine anti-polish ring which is a separate piece from the cylinder liner and is configured so that its radial edge is radially pressed toward the piston. This selectively operable pressing feature may be provided by a bi-metal or by a pressurized fluid.

Applicants' invention, as defined by base Claims 1 and 3 is, *inter alia*, a diesel engine piston crown having a diameter of at least 180 mm., wherein the sidewall of the crown bowl has an acute re-entrant angle. Applicants' invention, as additionally defined by base Claim 11, is a piston-cylinder combination, wherein a cylinder liner of the cylinder is integrally formed as a single piece with an anti-polish ring.

Argument in Support of Allowance:

With regard to Claims 1-10:

It is longstanding practice in the art of diesel engine engineering to provide diesel engine pistons having diameters more than 180 mm. with an obtuse re-entrant angle of the crown bowl sidewall. There is an engineering reason for this, which was extensively recounted by Applicants in the specification as originally filed on pages 1 through 4. Particularly, paragraphs 0007 through 0011 of the specification describe the situation in the mind of an artisan of ordinary skill:

Piston configurations having combustion optimization features such as a deep crown bowl and an acute reentrant angle of the bowl outer sidewall shape can be found in the prior art with respect to small-bore, high-speed (cylinder bores of less than 100 mm and speeds greater than 2,500 rpm) diesel engines, as well as medium-bore, high-speed (cylinder bores of from 80 to between 140 and 180 mm and speeds greater than

1,800 rpm) diesel engines.

As the diesel engine size decreases, in addition to fuel jet momentum, increasing amounts of air swirl are used to achieve faster fuel-air mixing rates. The air swirl is generated by suitably shaped air inlet ports, and is amplified during compression by forcing most of the air toward the cylinder axis into the deep crown bowl combustion chamber. In this regard, smaller diameter, deeper crown bowls will generate greater air swirl as air inlet port generated swirl is compressed into the small diameter crown bowl. Because of conservation of angular momentum, the reduction in cylinder diameter greatly accelerates the angular velocity of the air. Further, air swirl helps to minimize the fuel spray jet impingement on the crown bowl sidewall. Without appropriate air swirl (air motion), fuel spray impingement leads to sidewall wetting, which increases production of certain undesired (ie., hydrocarbon) emissions and component wear (for example, metal erosion and increased friction due to dilution of lubricating oil). In general, the small-bore and medium-bore, high-speed diesel engines are subjected to lower mechanical and thermal loads when compared to large-bore, medium speed diesel engines. Consequently, the crown bowl designs for small-bore and medium-bore, high speed diesel engines are more flexible than large-bore, medium speed diesel engines with respect to reentrant angle of the crown bowl sidewall and the contours of bowl edge (sharp or rounded reentrant lip).

Referring now to Figure 1, a typical large-bore, low speed diesel engine includes a plurality of cylinders, each cylinder 10 having a cylinder liner wall 12, a cylinder head 14 and a reciprocating piston 16 having a piston crown 18 at the top of the piston, which forms part of the combustion chamber 20. The piston crown 18 includes, typically, a crown bowl 22, a piston ring pack 24, a piston squish face 26, and top land 28, which in combination influence the nature of fuel combustion, heat transfer, and engine emissions characteristics. Pistons 16 can be configured with different shapes of the crown bowl 22, such as for example by variation of bowl depth MD (ie., shallow or deep), bowl shape (ie., hemispherical, cylindrical), angle B of the bowl inner wall W, bowl reentrant angle  $A_o$  (which is obtuse) of a tangent T of the bowl sidewall S with respect to a plane  $P_F$  parallel to the piston squish face 26, bowl radius R, as well as squish height S between the piston squish face and the cylinder head 14 when the piston is at top dead center (as shown at Figure 1), and top land height TL, to obtain specific geometry, compression ratio, and desired air-fuel mixing conditions.

However, in the case of large-bore, medium speed diesel engines, the momentum and energy of the injected fuel is sufficient to achieve adequate fuel distribution and rates of mixing with the air. Accordingly, the

customary crown bowl shape is shallow and has an obtuse reentrant angle of the crown bowl sidewall. Particular crown bowl shapes are unique to various engine manufacturers with many individual features satisfying particular applications.

Accordingly, what remains needed in the art is advancement in the piston crown bowl shape of large-bore, medium-speed diesel engines to further optimize fuel spray, in-cylinder air motion, and fuel air mixing to lower undesired emission without paying a severe penalty in regard to fuel economy and/or reliability of the engine.

Thus, a an artisan of ordinary skill in the art who reads Zhu et al would see an *obtuse* re-entrant angle crown bowl sidewall being applied to a diesel engine piston of over 180 mm. and this would satisfactorily reinforce his/her knowledge and experience that obtuse re-entrant angles are used for diesel engine pistons over 180 mm in diameter.

Now if this person of ordinary skill were to read also Liu et al, he/she would see an acute re-entrant angle of the sidewall of the crown bowl, but since Liu et al is silent as to diameter, there is no way for the artisan to think that this is anything other than conventional wisdom being applied to pistons of diameter less than 180 mm. Indeed, this artisan would need inventive inspiration to disregard his/her experience and oppositely reconstruct the piston of Zhu et al so as to apply an acute re-entrant angle sidewall to a diesel engine piston of over 180 mm.

Thus, it is inescapable that an artisan of ordinary skill who reads Zhu et al and Liu et al would only remain aware of the standard practice in the art to provide diesel engine pistons having diameters over 180 mm with an obtuse re-entrant angle sidewall.

With regard to Claims 11 and 12:

As Applicants have recounted on page 5 of the specification as originally filed, it is prior art custom to provide an anti-polish ring as an insert of the cylinder liner. If an artisan of ordinary skill who is in possession of this knowledge now reads Paro he/she would come away

with a reinforced engineering conviction that the anti-polish ring must be in the form of a separate insert of the cylinder liner, since this is exactly what Paro teaches.

There is no teaching or suggestion in Paro that the anti-polish ring could be an integral part of the cylinder liner. And, since it is against conventional engineering wisdom, as taught by Paro, to make the anti-polish ring integral with the cylinder liner, only by inventive inspiration could an artisan of ordinary skill arrive at Applicants' novel cylinder liner and integral anti-polish ring.

Additionally, Applicants' wish to very courteously point out that however it may be that the anti-polish ring is being claimed by Applicants, such as for example in the alternative, this cannot in any way be construed as an admission of the state of the prior art, nor the state of mind of an artisan of ordinary skill.

In view of the foregoing remarks, Applicants respectfully request the Examiner to withdraw the rejection under 35 U.S.C. 103 as regards amended base Claims 1, 3 and 11, and, under the principle that dependent claims merely further define their respective base claims, that the rejection be withdrawn as regards Claims 2, 4-10 and 12.

#### **Information Disclosure Statement**

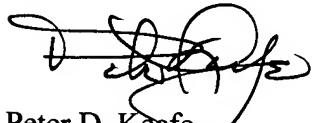
Applicants wish to courteously request the Examiner to initial the "Other Documents" citation entitled "Influence of Geometry..." on page 2 of the IDS submitted by Applicants.

#### **Conclusion**

It is respectfully submitted that Applicants have responded in a fully satisfactory manner

to all matters at issue in this Application, and that this Application is now in condition for allowance. In this regard, Applicants have made every effort to comply with the requirements set forth in the Office Action as well as the statutory requirements. Accordingly, Applicants respectfully request that the Examiner enter this Amendment, allow the claims, and pass this Application on to issue.

Respectfully submitted,



Peter D. Keefe  
Reg. No. 31,114

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Peter D. Keefe  
General Motors Corporation  
Legal Staff  
Mail Code 482-C23-B21  
P.O. Box 300  
Detroit, MI 48265

Tel. (586) 775-5680  
Fax. (586) 775-2769